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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

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TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371

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U.S. APPLICATION NO. (if known, see 37 CFR 1.5)

09/787720

INTERNATIONAL APPLICATION NO.

PCT/JP99/05258

INTERNATIONAL FILING DATE

27 September 1999 (27.09.99)

PRIORITY DATE CLAIMED

28 September 1998 (28.09.98)

TITLE OF INVENTION VERTICAL FURNACE AND WAFER BOAT FOR VERTICAL FURNACE

APPLICANT(S) FOR DO/EO/US TSURUKI, MASAKI and MACHIDA, TAKASHI

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☒ has been transmitted by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

## Items 11. to 16. below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.  
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☒ A change of power of attorney and/or address letter.
16. ☒ Other items or information:

International Publication No. WO00/19502-cover sheet

International Search Report

Information Disclosure Sheet Under 37 CFR 1.56 w/refs.

Figs. 1-13

Credit Card Payment form

- 17.
- ☒
- The following fees are submitted:

**BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :**

Neither international preliminary examination fee (37 CFR 1.482)  
nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO  
and International Search Report not prepared by the EPO or JPO ..... \$970.00

International preliminary examination fee (37 CFR 1.482) not paid to  
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International preliminary examination fee (37 CFR 1.482) not paid to USPTO but  
international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$690.00

International preliminary examination fee paid to USPTO (37 CFR 1.482)  
but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$670.00

International preliminary examination fee paid to USPTO (37 CFR 1.482)  
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**ENTER APPROPRIATE BASIC FEE AMOUNT =****CALCULATIONS PTO USE ONLY**

\$ 860.00

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30  
months from the earliest claimed priority date (37 CFR 1.492(e)).

\$ 0.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	8 - 20 =	0	X \$18.00
Independent claims	5 - 3 =	2	X \$78.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$260.00

\$ 0.00

\$ 0.00

**TOTAL OF ABOVE CALCULATIONS =**

\$ 1,020.00

Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement  
must also be filed (Note 37 CFR 1.9, 1.27, 1.28).

\$ 0.00

**SUBTOTAL =**

\$ 1,020.00

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30  
months from the earliest claimed priority date (37 CFR 1.492(f)).

\$ 0.00

**TOTAL NATIONAL FEE =**

\$ 1,020.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be  
accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +

\$ 0.00

**TOTAL FEES ENCLOSED =**

\$ 1,020.00

Amount to be

refunded: \$

charged: \$

- a. ☒ A check in the amount of \$ 1,020.00 to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_ to cover the above fees.  
A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any  
overpayment to Deposit Account No. 01-2135. A duplicate copy of this sheet is enclosed.

**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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*William I. Solomon*  
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NAME

28,565

REGISTRATION NUMBER

12/PRTS

JC10 Rec'd PCT/PTO 2 2 MAR 2001 8/8

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## SPECIFICATION

VERTICAL FURNACE AND WAFER BOAT FOR VERTICAL FURNACE

## Technical Field

The present invention relates to a vertical furnace and a wafer boat incorporated in a vertical furnace, and in particular to a vertical wafer boat incorporated in a vertical diffusion furnace or a vertical vapor growth furnace.

## Background Of The Invention

In an oxidation and diffusion process for semiconductor wafers, a wafer boat carrying thereon several semiconductor wafers is introduced into a diffusion furnace so as to subject the semiconductor wafers to a predetermined heat-treatment process. There may be used a vertical wafer boat or a horizontal wafer boat in accordance with a type of the diffusion furnace.

There has been conventionally used a wafer boat having a structure for holding a wafer at three or four points, and having rod-like support parts which project from the boat, and boat support columns in order to support the wafer having its peripheral end parts and its rear surface of the wafer made into surface contact with the boat support columns and the support parts, respectively. (Japanese Patent Laid-

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Open No. S61-191015).

Further, there has been used a wafer boat in which the boat support columns are formed therein with grooves having a thickness slightly larger than the thickness of a wafer, for supporting a wafer having its peripheral end part and the peripheral part of its rear surface made into surface contact with the grooves.

These years, there has been such a tendency that the diameter of wafers has been larger and larger. In particular, should a wafer have a diameter larger than 30 cm (12 inch), the wafer would be warped by its dead weight, finally causing a problem of occurrence of crystal defect such as a slip. In order to solve this problem, a boat which supports a wafer at positions far from the peripheral part of the wafer but near to the center thereof has been used (Japanese Laid-Open Patent No. H06-169010 and Japanese Laid-Open Patent No. H09-139352).

Alternatively, arcuate or ring-like support members are provided to the boat support columns so as to support the wafer having the peripheral edge part of its rear surface made into surface contact with these members (Japanese Laid-Open Patent No. H6-260438).

#### Disclosure Of Invention

In the conventional technology for supporting a wafer in a point contact manner, the contact area is inevitably limited even though the inside part of the

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wafer is supported, and accordingly, a wafer having a large dead weight causes stress to increase at a supported position, and its yield stress to decrease due to a higher process temperature. Thus, a generated stress readily exceeds the yield stress, resulting in occurrence of a slip.

Further, it has been required for supporting a wafer to form deep slits or support rods in and on the support members, and accordingly, there has been raised a problem of increasing the time and labor, and as well a problem of increasing the costs.

As mentioned above, there has been used such a conventional technology that a wafer is supported at its peripheral edge by an arcuate or ring-like support member through surface-contact. However, even in this configuration, there has been a problem such that a slip inevitably occurs even under such a condition that the process temperature for the wafer exceeds 1,000 deg.C.

In order to solve the above-mentioned problem, in a vertical wafer boat in which a wafer is made into surface-contact with the upper surface of the arcuate or ring-like support so as to support the wafer, the support member is formed in its upper surface with groove-like cutouts at positions which make an angle of 45 deg. with respect to the wafer inserting direction of the wafer boat at the center of the arcuate or ring-like support member in order to

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prevent the support members from making contact with the wafer.

Explanation will be made of the reason why the above-mentioned configuration has been taken. Even though the lower surface of the wafer is made into surface contact with the arcuate or ring-like support member so as to support the wafer, the support member is not made into contact with the lower surface of the wafer over its entire surface. That is, microscopically, the wafer is supported in such a condition that the support member is in part made into contact with the wafer due to a warp of the wafer or the support member, caused by their deadweights or temperature distribution, or unevenness due to surface roughness, manufacturing accuracy and the like. Accordingly, a stress which is greater than that obtained when it is uniformly contact with the wafer is presented at a contact position.

Table 1 shows the relationship between the position where a slip occurs and the frequency thereof in such a case that a wafer having a diameter of about 30 cm (12 inches) and using {001} as a principal planes is set so as to align a <110> direction with its inserting direction and is supported by a ring-like support member, and they are thermally treated at temperatures 1050 deg.C, 1,100 deg.C and 1,200 deg.C. The position of occurrence of a slip is indicated by a center angle of 0 to 45 deg. with respect to the wafer

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inserting direction with the estimation of a 1/8 mirror surface symmetry. From Table 1, it is found that the frequency of occurrence of a slip is higher at a position around the center angle of 45 deg. than that at any other position. That is, the wafer using {001} as a principal plane and <110> direction as an inserting direction exhibits such a tendency that a slip possibly occurs at positions which make a center angle of 45 deg. with respect to the wafer inserting direction, that is, in four directions of <100>, <010>, <100> and <0-10>. Accordingly, with the prevention of contact between the wafer and the support member in this four directions, it is possible to restrain occurrence of a slip.

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Table 1

		Position (Center Angle)					
		0~7.5	7.5~15	15~22.5	22.5~30	30~37.5	37.5~45
Temp. (°C)	1,050	1	1	0	0	0	4
	1,100	2	1	0	0	1	6
	1,200	2	2	5	0	0	6
Total		5	5	5	0	1	16

## Brief Description Of The Drawings:

Fig. 1 is a transverse sectional view illustrating a vertical diffusion furnace (vapor phase growth furnace) in an embodiment of the present

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invention;

Fig. 2 is a view illustrating an entire configuration of a vertical wafer boat in the embodiment of the present invention;

5 Fig. 3 is a cross-sectional view along line A-A' in Fig. 1, illustrating the vertical wafer boat in the first embodiment of the present invention;

Fig. 4 is a plan view illustrating a support member in the vertical wafer boat, for explaining the configuration of the embodiment of the present invention;

Fig. 5 is side views illustrating shapes of a groove in the support member of the vertical wafer boat in the embodiment of the present invention;

15 Fig. 6 is a plan view illustrating the support member of the vertical wafer boat in another embodiment of the present invention;

Fig. 7 is a plan view illustrating support member in the vertical wafer boat in further another embodiment of the present invention;

Fig. 8 is a plan view illustrating a support member in a vertical wafer boat in further another embodiment of the present invention;

Fig. 9 is a plan view illustrating a support member in a vertical wafer boat in further another embodiment of the present invention;

Fig. 10 is a plan view illustrating a support member in a vertical wafer boat in further another

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embodiment of the present invention;

Fig. 11 is a plan view illustrating a support member in a vertical wafer boat in further another embodiment of the present invention;

5 Fig. 12 is a plan view illustrating a support member in a vertical wafer boat in further another embodiment of the present invention; and

Fig. 13 is a view showing a relationship between a center angle of a groove in the support member of a vertical wafer boat in further another embodiment of the present invention, and a stress generated in a wafer.

#### Best Modes Of The Invention

Explanation will be hereinbelow made of the present invention with reference to the drawings.

Referring to Fig. 1, a reaction pipe incorporated in a vertical resistance heating furnace 1 has a double structure composed of an outer tube 2 and an inner tube 3, and is supported on a base 4.

20 Reaction gas is fed into the inner tube 3, and is extracted from the inner tube 2. A boat 5 is set in the inner tube 3, and inserted into and pulled out from the inner tube 3 through a circular hole 6 formed in the center part of the base 4. Wafers are held in the

25 boat 5 at arbitrary intervals in the vertical direction. The wafers are shifted to and from the boat 5 taken out from the inner tube 3.

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Referring to Fig. 2 which is a view illustrating the entire configuration of the boat 5, the boat 5 comprises a plurality of support columns 8, a top panel 51, a bottom panel 62 and a cap 53.

5 Referring to Fig. 3 which is a cross-sectional view along line A-A' in Fig. 1 as viewed in the vertical direction, illustrating the boat 5, the boat 5 holding therein a plurality of wafers 7 in substantially horizontal postures comprises a plurality  
10 of support columns 8, and a plurality of support members 9. The plurality of support columns 8 are planted substantially upright, surrounding the peripheries of the wafers 7 held in the boat 5. Since the wafers 7 are inserted in a horizontal direction  
15 into the boat 5, the space between the support columns 8 is widened in the insertion part therefore in order to ensure an insertion space for the wafers 7. The support members 9 have an arcuate or ring-like shape, and are integrally incorporated with the support  
20 columns 8 or are removably held in grooves formed in the support columns 8. The support members 9 hold the wafers 7, concentric with each other. That is, in the supported condition, the centers of the wafers 7 are substantially coincident with the centers of the arcs  
25 or rings of the support members 9. It is noted that the inserting direction of each wafer 7 is set so as to pass through the center of the associated support member 9.

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Referring Fig. 4 which is an example of the support member 9 in this embodiment, the support member 9 is ring-like, and is formed in its upper surface with four grooves in directions which make an angle of 45 deg. with respect to the wafer inserting direction at the center of the ring of the support member 9. These grooves prevent the lower surface of a {001} wafer 7 from making contact with the support member 9 in  $\langle 100 \rangle$ ,  $\langle 010 \rangle$ ,  $\langle -100 \rangle$  and  $\langle 0-10 \rangle$  directions.

The grooves 10 have a rectangular cross-sectional shape.

However the grooves 10 may have any of various shapes if it has a depth with which the lower surface of the wafer 7 can be prevented from the upper surface of the support member 9, that is, it may be a recess, a hole or the like. Fig. 5 is side views which show examples of the grooves 10. In addition, the grooves shown Fig. 5(a) (corners of a rectangular cross-sectional shape of the groove have a curvature), Fig. 5(b) (corners of a rectangular cross-sectional shape of the groove are chamfered), Fig. 5(c) (a groove having a V-like cross-sectional shape, Fig. 5(d) (a groove having a trapezoidal cross-sectional shape), and Fig. 5(e) (a corner of a V-like or trapezoidal cross-sectional shape of a groove has a curvature) exhibit similar technical effects and advantages.

The wafer 7 and the support member 9 are made into point or line contact with each other at end parts

of the grooves or cutouts or surface contact which is substantially identical with point or line contact, with the each other, and accordingly, large stresses would be possibly caused in the parts of the wafer 7 which make contact with the end parts of the grooves or cutouts. Accordingly, it is desirable that the grooves and cutouts are formed so as to have curvatures at the end parts or edges thereof in order to increase the contact areas of the wafer at the end parts of the grooves or cutouts, since there has been such an effect that the stresses can be reduced.

Even though the grooves and cutouts exhibit such an effect as to restrain occurrence of inappropriate stresses which are caused by contact between the grooves or cutouts and the wafer so as to result in occurrence of a slip, it is natural that the wafer cannot be supported by the support member in zones where the grooves or cutouts are formed. Accordingly, the wafer is bent in these zone due to the deadweight of the wafer. The greater the circumferential width of the grooves or cutouts, the higher the stresses. It is required that the circumferential width of the grooves or cutouts is set to an appropriate value.

Referring to Fig. 13 which shows a result of FEM analysis of circumferential stress caused at the centers of grooves in the wafer with respect to center angles of the grooves as parameters, in such a case

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that a wafer having a diameter of 30 cm (12 inches) and having {001} as a principal plane is supported by a support member formed therein with grooves at positions making angle of 45 deg. with respect to the inserting direction of the wafer with such an estimation that the groove width has a certain center (the angle of an arc in such a case that the groove width is regarded as an arc), the stress is exhibited by a ratio to a stress caused a groove having a center angle of zero, that is, no groove is present.

Accordingly, the center angle of the grooves or cutouts is preferably less than 12 deg. with which an increment of the stress caused by each of the grooves or cutouts does not exceed 1/10 of a stress which is caused when no groove is present, and if possible, it is preferably less than 6 deg. with which the increment of the stress can be less than 1/100. It is noted that in this embodiment, the center angle is set to about 4 deg.

Fig. 6 shows another example of the support member 9. In the support member 9 in this embodiment, an arcuate part forward in the direction of wafer insertion is widely opened in order to enable a shifting device for the wafers 7 to be inserted therethrough. If the part has a suitable width so that the supporting of the wafer becomes uneven so as to cause stresses, no slip is caused.

Fig. 7 shows further another example of the

support member 9, instead of the grooves 10, cutouts 11 are formed in the support member 9. In this structure, the thickness of the support member 9 can be reduced in comparison with that formed therein with the grooves 10, and as a result, there can be provided a wafer boat in which a larger number of the wafer can be mounted although the boat has an equal height. Further, with this structure, although a high stress is caused in a narrow part of the cutout, by suitably designing the structure and by suitably selecting a material, the reliability can be ensured.

Referring to Fig. 8 which shows further another example of the support member 9, in order to insert the wafer shifting device behind the wafer, the outer peripheral side of the support member 9 is set back outward so as to ensure a space inward in the wafer inserting direction. Alternatively, the curvature may be increased in this part.

Further, as shown in Fig. 9, even though the groove 10 is not formed in every of all four directions, but is formed in some thereof, the provability of occurrence of a slip can be reduced, that is, the number of slips caused in a single wafer can be reduced, thereby it is possible to effect such an advantage that the yield of the device can be increased.

Further, referring to Fig. 10 which shows another example of the support member 9. The thinner

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the wall thickness, the lower the rigidity, the wafer could not be supported or the stress caused by contact would be increased, resulting in a main cause of occurrence of a slip. However, if the wall thickness is increased, pitches of the grooves for supporting the support members become larger, and accordingly, the number of wafers which can be mounted on the boat 5 at a time, is inevitably decreased. Further, should the wall thickness be increased, the weight would be increased, and accordingly, the load to the support columns of the boat would be increased or the overall size of the device would become huge. Further, it causes an increase in the costs. In the embodiment shown in Fig. 10, the support member 9 has a L-like cross-sectional shape. The wall thickness of parts of the support member where the support member is mounted or removed is small but that of the other parts is large. Thus, the pitches of grooves for mounting and removing the support members can be prevented from increasing, and further, the weight can be restrained from increasing, thereby it is possible to ensure the rigidity of the support member 9. In order to reduce the weight of the support member 9 without lowering the rigidity of the support member 9, instead of increasing the wall thickness, it is effective to form reinforcing ribs at the rear surface of the support member, in the circumferential or radial direction thereof.

Referring to Fig. 11 which shows further

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another example of the support member 9, the support member 9 has an arcuate shape so that a part at least from an angle of -45 deg. to an angle of +45 deg. with respect to the inserting direction of the wafer at the center of the arc of the support member 9 is opened forward in the direction of the wafer insertion in order to prevent the wafer from making contact with the support member at a position where the yield stress become smallest and in order to enable the insertion of the wafer shifting device.

Referring Fig. 12 which shows further another example of the support members 9, the support members 9 are integrally incorporated with the support columns 8.

According to the present invention, the diameter of the wafer is increased, the occurrence of stress due to contact with the support member in the case of increasing the process temperature can be restrained, and accordingly, it is possible to prevent occurrence of a slip in the contact part between the wafer and the boat during heat treatment in a vertical diffusion furnace or a vertical vapor growth furnace. As a result, affection upon the device characteristic due to a slip can be eliminated, thereby it is possible to exhibit a remarkable effect for enhancing the yield of devices.

## CLAIMS

1. A vertical furnace comprising:  
a reaction pipe located in a heating furnace;  
a means for feeding reaction gas into the reaction pipe; and  
a means of holding a wafer in the reaction pipe;  
wherein the wafer has {001} as a main principal plane and is heated in a condition in which the wafer is prevented from making contact with the holding means in crystal orientations  $\langle 100 \rangle$ ,  $\langle 010 \rangle$ ,  $\langle -100 \rangle$  and  $\langle 0-10 \rangle$ .
2. A vertical furnace as set forth in claim 1, wherein the reaction tube has a double structure composed of an outer tube and an inner tube, and the wafer is adapted to be located in the inner tube.
3. A heat treat method wherein a wafer having {001} as a principal plane is heat treated in such a condition that the wafer is not supported in crystal orientations  $\langle 100 \rangle$ ,  $\langle 010 \rangle$ ,  $\langle -100 \rangle$  and  $\langle 0-10 \rangle$ .
4. A heat treat method wherein a wafer having {001} as a principal plane is heat treated after the wafer is supported at desired positions other than crystal orientations  $\langle 100 \rangle$ ,  $\langle 010 \rangle$ ,  $\langle -100 \rangle$  and  $\langle 0-10 \rangle$ .
5. A wafer boat for a vertical furnace, comprising a plurality of vertically arranged support columns, and support members for wafers, supported to the support columns at predetermined pitches in the

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vertical direction, the support members supporting the wafers so as to be made into surface contact with the peripheral edge parts of the wafers, characterized in that groove-like cutouts for preventing the support member from making contact with the wafers are formed in the support members in surfaces on the side where the support members support the wafers, at positions making angle of 45 deg. with respect to an inserting direction of the wafers at the center of an arc or a ring of each of the support members.

6. A wafer boat for a vertical furnace as set forth in claim 5, characterized in that the support members are not provided in a range from an angle of +45 deg. to an angle of -45 deg. with respect to the inserting direction of the wafer.

7. A wafer boat for a vertical furnace as set forth in claim 5, characterized in that a curvature is formed in an end part of each of the groove-like cutouts.

8. A wafer boat for a vertical furnace, comprising a plurality of vertically arranged support columns, and support members for wafers, supported to the support columns at predetermined pitches in the vertical direction, the support members supporting the wafers so as to be made into surface contact with the peripheral edge parts of the wafers, characterized in that the support members are formed therein with groove-like cutouts for preventing themselves from

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making contact with the wafers each having {001} as a principal plane crystal, in crystal orientations  $\langle 100 \rangle$ ,  $\langle -100 \rangle$ ,  $\langle 010 \rangle$  and  $\langle 0-10 \rangle$ .

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## ABSTRACT

A wafer boat for a vertical furnace, for supporting a wafer at the peripheral edge part thereof by means of an arcuate support member through surface contact, wherein the support member is formed in its surface on the side where the support member supports the wafer, with groove-like cutouts at positions making an angle of 45 deg. with respect to an inserting direction of the wafer at the center of the arc of the support member.

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PTO/SB/106(8-96)  
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Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

#4

## Declaration and Power of Attorney For Patent Application

### 特許出願宣言書及び委任状

### Japanese Language Declaration

### 日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

VERTICAL FURNACE AND WAFER BOAT FOR

VERTICAL FURNACE

上記発明の明細書（下記の欄で×印がついていない場合は、本書に添付）は、

The specification of which is attached hereto unless the following box is checked:

☐ 月 日に提出され、米国出願番号または特許協定条約国際出願番号を \_\_\_\_\_ とし、  
（該当する場合） \_\_\_\_\_ に訂正されました。

☒ was filed on March 22, 2001  
as United States Application Number or  
PCT International Application Number  
09/787,720 and was amended on  
\_\_\_\_\_ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されたとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

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FIG. 1

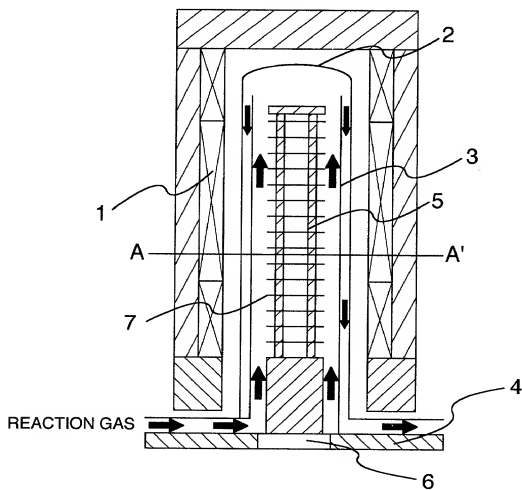


FIG. 2

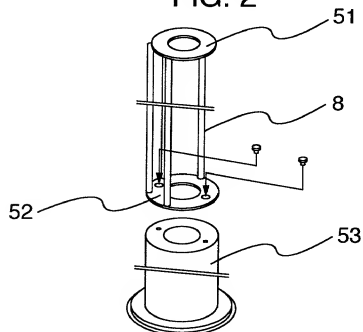


FIG. 3

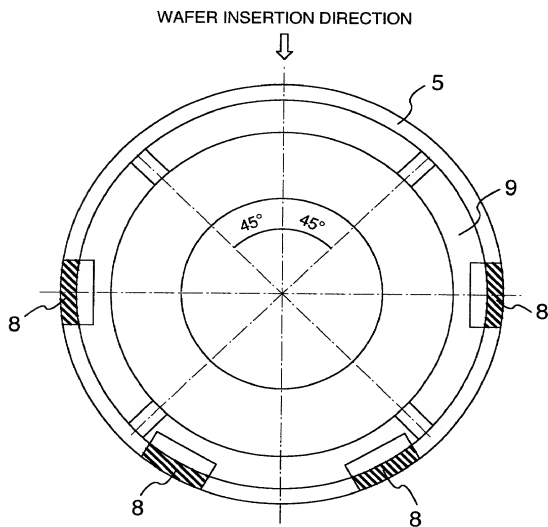


FIG. 4

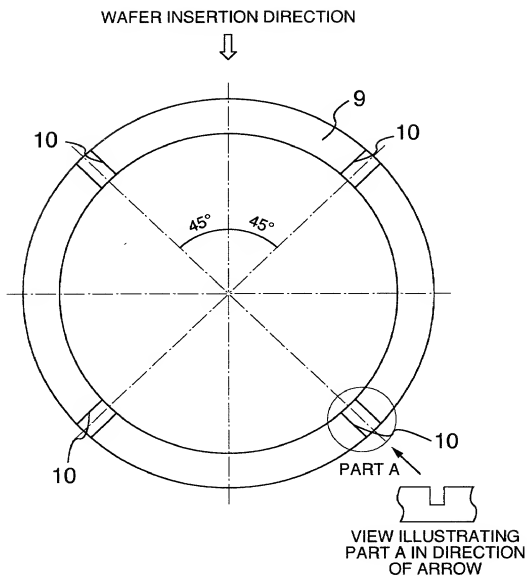
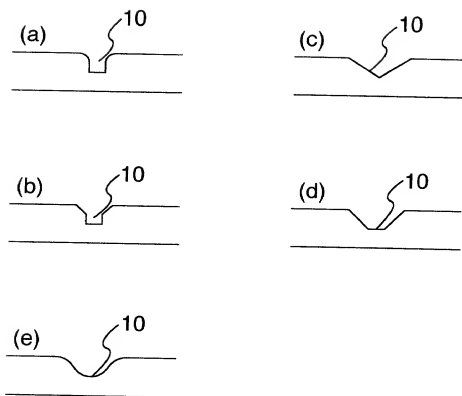
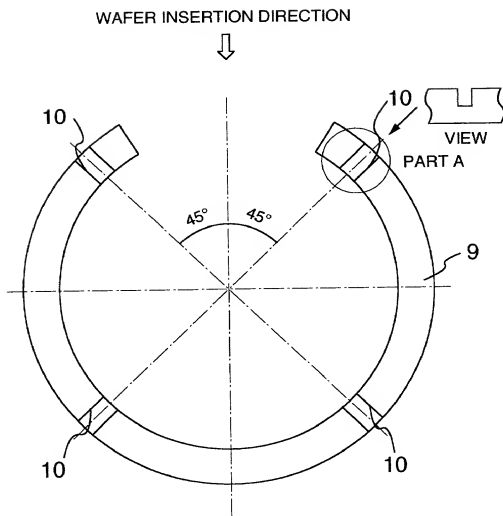


FIG. 5



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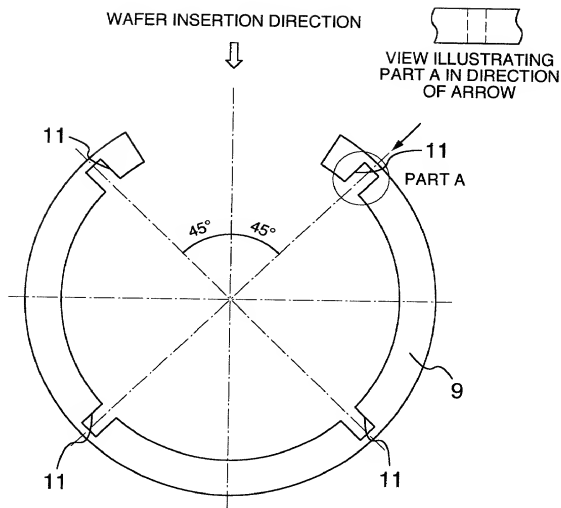
FIG. 6



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FIG. 7



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FIG. 8

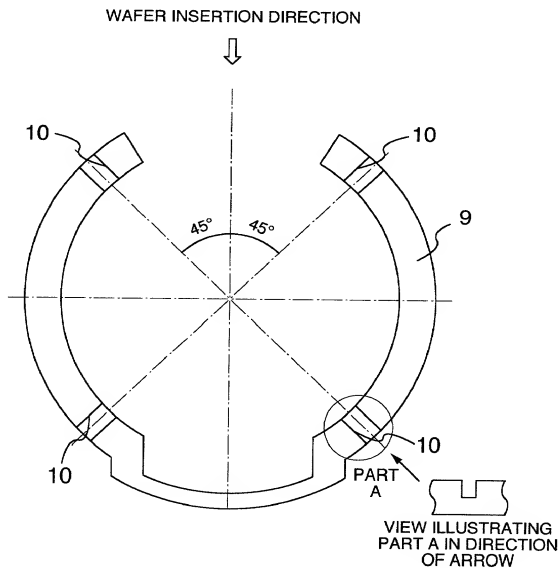
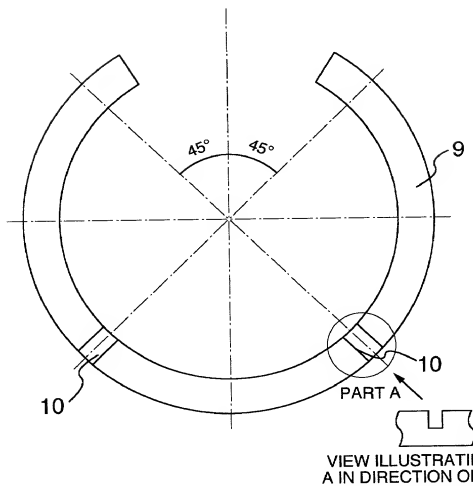


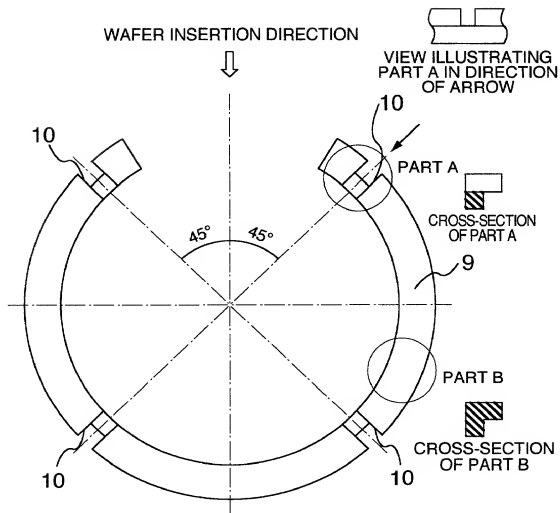
FIG. 9

WAFER INSERTION DIRECTION



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FIG. 10



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FIG. 11

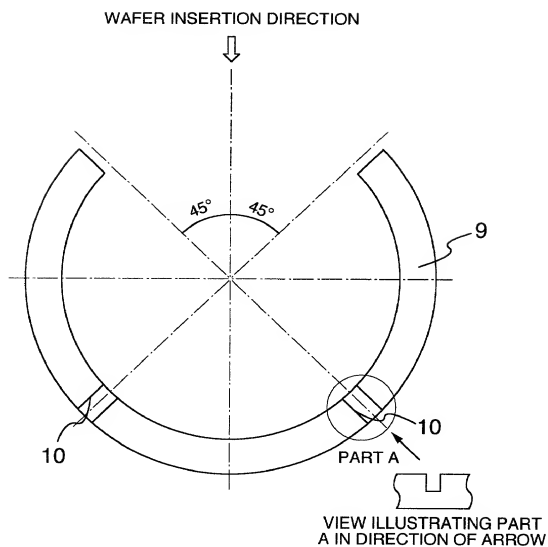


FIG. 12

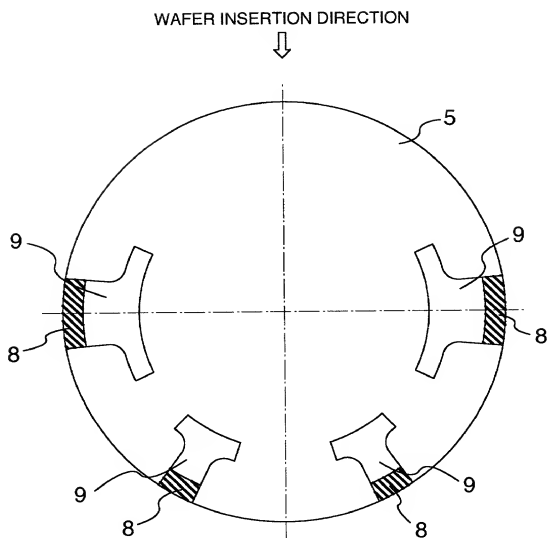
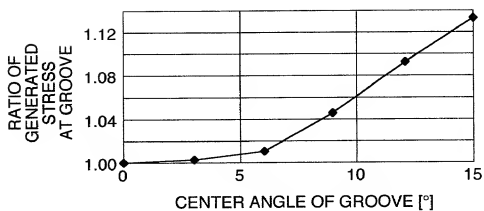


FIG. 13





PTO/SB/106(8-96)

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#4

## Declaration and Power of Attorney For Patent Application

## 特許出願宣言書及び委任状

## Japanese Language Declaration

## 日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

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上記発明の明細書（下記の欄で印がついていない場合は、本書に添付）は、

The specification of which is attached hereto unless the following box is checked

☐ 月 日に提出され、米国出願番号または特許協定条約  
国際出願番号を \_\_\_\_\_ とし、  
(該当する場合) \_\_\_\_\_ に訂正されました。☒ was filed on Mar 22, 2001  
as United States Application Number or  
PCT International Application Number  
09/787,720 and was amended on \_\_\_\_\_  
(if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56

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私は、米国法典第35編119条(a)-(d)項又は365条(b)項に基づき下記の、米国外の国の少なくとも一方国を指定している特許協力条約365(a)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示している。

## Prior Foreign Application(s)

外国での先行出願

<u>10-272901</u>	<u>Japan</u>
(Number)	(Country)
(番号)	(国名)
(Number)	(Country)
(番号)	(国名)

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(Application No.)	(Filing Date)
(出願番号)	(出願日)

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<u>PCT/JP99/05258</u>	<u>September 27, 1999</u>
(Application No.)	(Filing Date)
(出願番号)	(出願日)

(Application No.)	(Filing Date)
(出願番号)	(出願日)

私は、私自身の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じているところに基づき表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第18編第1001条に基づき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の表明を行えば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Priority Not Claimed  
優先権主張なし

<u>28/September/1998</u>
(Day/Month/Year Filed)
(出願年月日)
(Day/Month/Year Filed)
(出願年月日)

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)	(Filing Date)
(出願番号)	(出願日)

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of application.

<u>Pending</u>
(Status: Patented, Pending, Abandoned)
(現況: 特許許可済、係属中、放棄済)

(Status: Patented, Pending, Abandoned)
(現況: 特許許可済、係属中、放棄済)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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委任状： 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。(弁理士、または代理人の氏名及び登録番号を明記のこと)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)

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国籍		Citizenship Japan
私書箱		Post Office Address c/o Hitachi, Ltd., Intellectual Property Group New Marunouchi Bldg. 5-1, Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-8220, Japan

(第二以降の共同発明者についても同様に記載し、署名をする  
こと)

(Supply similar information and signature for second and  
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第二共同発明者の署名	日付	Takashi MACHIDA Second inventor's signature Date Takashi Machida 6/20/01
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第三共同発明者の署名	日付	Toshimitsu MIYATA Third inventor's signature Date Toshimitsu Miyata 6/22/01
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第五共同発明者		Full name of fifth joint inventor, if any
第五共同発明者の署名	日付	Fifth inventor's signature Date
住所		Residence
国籍		Citizenship
私書箱		Post Office Address

(第六以降の共同発明者についても同様に記載し、署名をすること)

(Supply similar information and signature for sixth and subsequent joint inventors.)

0973720 071101

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第六共同発明者		Full name of sixth joint inventor, if any	
第六共同発明者の署名	日付	Sixth inventor's signature	Date
住所		Residence	
国籍		Citizenship	
私書箱		Post Office Address	
第七共同発明者		Full name of seventh joint inventor, if any	
第七共同発明者の署名	日付	Seventh inventor's signature	Date
住所		Residence	
国籍		Citizenship	
私書箱		Post Office Address	
第八共同発明者		Full name of eighth joint inventor, if any	
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住所		Residence	
国籍		Citizenship	
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第九共同発明者		Full name of ninth joint inventor, if any	
第九共同発明者の署名	日付	Ninth inventor's signature	Date
住所		Residence	
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(第十以降の共同発明者についても同様に記載し、署名をすること)

(Supply similar information and signature for tenth and subsequent joint inventors.)